WHAT IS CLAIMED IS:

1. A cooling apparatus for cooling an optical element provided in a vacuum atmosphere, said cooling apparatus comprising:

a radiational cooling part, arranged apart from the optical element, for cooling the optical element by radiation heat transfer; and

a controller for controlling temperature of the radiational cooling part.

2. A cooling apparatus according to claim 1, further comprising a sensor for detecting temperature of the optical element, wherein said controller controls said radiational cooling part so that the temperature detected by said sensor may be a predetermined value.

3. A cooling apparatus according to claim 1, wherein said controller includes a coolant feed part, formed in said radiational cooling part, for flowing coolant along a channel for coolant to flow through.

4. A cooling apparatus according to claim 3, wherein the temperature of the coolant is set to be substantially constant.

5. A cooling apparatus according to claim 3, wherein said controller controls temperature of the radiational cooling part so that temperature of the optical element may be a predetermined value and temperature of the coolant is substantially the same as the predetermined value.

6. A cooling apparatus according to claim 1, further comprising a radiation shielding member that prevents said radiational cooling part from absorbing the heat from a member other than the optical element.

7. A cooling apparatus according to claim 1, wherein said radiational cooling part includes:

a cold plate forms a temperature difference from the optical element;

a Peltier element, controlled by said controller and coupled with the cold plate, for cooling the cold plate using a Peltier effect; and

a radiator block that includes a channel for coolant to flow through, and draws heat from said Peltier element,

wherein said controller has a coolant feed part for flowing the coolant along the channel.

8. A cooling apparatus according to claim 7, wherein temperature of the coolant is set to be substantially constant.

9. A cooling apparatus according to claim 7, wherein said controller controls temperature of said radiational cooling part so that temperature of the optical element may be a predetermined value, and temperature of the coolant is substantially the same as the predetermined value.

10. A cooling apparatus according to claim 7, further comprising a radiation shielding member that prevents said radiational cooling part from absorbing the heat from a member other than the optical element.

11. A cooling apparatus according to claim 10, wherein said optical element is a mirror, wherein said radiational cooling part is provided on a rear surface side of the mirror.

12. A cooling apparatus according to claim 7, wherein said coolant feed part flows the coolant along the channel.

13. A cooling apparatus according to claim 1, wherein the optical element is a mirror.

14. A method for cooling an optical element located in a vacuum atmosphere, said method comprising the steps of:

sensing temperature of the optical element; and

cooling a plate so that the temperature of the optical element detected by said sensing step may become a predetermined value, the plate being arranged apart from the optical element and absorbing heat from the optical element.

15. A method according to claim 14, wherein the cooling step flows coolant having substantially constant temperature to a channel formed in a radiator block provided at a heat exhaust side of a Peltier element connected to the plate.

16. A method according to claim 14, wherein the cooling step flows coolant having temperature that is substantially the same as a predetermined value to a channel formed in a radiator block provided at a heat exhaust side of a Peltier element connected to the plate.

17. An exposure apparatus that exposes an object using a pattern on a reticle or mask, said exposure apparatus comprising:

a cooling apparatus; and

an optical system that includes at least one optical element disposed in a vacuum atmosphere,

wherein said cooling apparatus includes:

a radiational cooling part, arranged apart from the at least optical element, for cooling the optical element by radiation heat transfer; and

a controller for controlling temperature of the radiation cooling part.

18. An exposure apparatus according to claim 17, wherein the optical element included in the optical system is a mirror arranged in an optical path from the reticle or the mask to the object.

19. An exposure apparatus according to claim 17, wherein light that passes from the reticle or the mask to the object trough the optical system has a wavelength of 10 nm to 15 nm.

20. A device fabrication method comprising the step of:

exposing an object using an exposure apparatus; and

performing a development process for the object exposed,

wherein an exposure apparatus includes:

a cooling apparatus; and

an optical system that includes an optical element cooled by said cooling apparatus, and exposes a pattern formed on a reticle or mask onto an object,

wherein said cooling apparatus includes:

a radiational cooling part, arranged apart from the optical element, for cooling the optical element by radiation heat transfer; and

a controller for controlling temperature of the radiation cooling part.